COMMENTS

Applicant confirms the election of claims 1-17 and cancels claims 18-20.

Applicant has revised the Abstract to overcome the objection of paragraph 7. The phrase "or other location" has been changed to — located on the base —. No new matter has been added. The changes are consistent with, e.g., Fig. 2, and the first full paragraph on page 7 of the specification. A clean Abstract is submitted herewith as a separate page, and the Appendix shows the changes.

In paragraph 8, the claim term "level sensors" is said to lack antecedent basis in the specification. However, page 7, lines 17-18 refers to "level sensors" and the subsequent lines explain their function.

In paragraph 10, claims 1-13 and 15 have been objected to under 35 U.S.C. § 112, second paragraph as indefinite. First, from the description at page 7 line 17 to page 8 line 8, the sensor package B includes sensors for correcting the stabilized position of the platform relative to the earth's horizon. Therefore, the level sensors referred to at lines 17 and 18 refer to sensors for detecting at least the "levelness" or absolute inclination or position of the platform which is relative to the predetermined position.

BACKGROUND

The use of two independent sensor packages located on the base 60 and the camera/payload platform 22 (or sensing the level of the payload platform relative to a fixed position) according to the present invention provides the distinct advantage of self leveling or self correcting. This accomplishes two distinct functions:

Function 1: The present invention automatically compensates for errors of motor and drive mechanism backlash, belt slippage, and corrects for damage or failures to the vehicle frame between the location of sensor package A and sensor package B. If backlash or belt slippage were to occur in the motor/gear drive mechanisms, sensor package B would cause the control system to continue to bring the camera/payload platform 22 back to level as governed by sensor package B. Concurrently, sensor package A would continue to correct for high rate vehicle motion. If the physical platform were to become damaged or bent between the location of sensor package A and B, sensor package B would continue to bring the camera/payload platform 22 back to level, thus correcting for damage automatically and on the fly while sensor package A would continue to correct for high rate vehicle motion.

Function 2: Sensor package A may consist of lightweight, low cost sensors such as rate sensors weighing only a few ounces, and costing less than $1,000 dollars. Sensor package A does not have to be linked to more expensive and precise sensors or INS systems to maintain accuracy over the long term from sensor anomalies or drift. This correction can be done by using sensor package B, which can be inexpensive level sensors costing less than rate sensors,

to provide position information preferably directly from the payload platform.

DISCUSSION OF THE CLAIMS

The present invention as now claimed in both claims 35 and 36 is a stabilized platform system including a pair of sensor packages. The first sensor package A is fixed to the base and the second sensor package B senses the level or relative position of the stabilized camera/payload platform. The sensor package A senses motion of a vehicle on which the stabilized platform is mounted. Sensor package B includes at least one level sensor sensing inclination of the stabilized camera/payload platform. A control system continually stabilizes the camera/payload platform based on information provided by the sensor package A. The control system corrects for sensor package A anomalies based on information provided periodically by sensor package B.

§102 - Buell

In the action, paragraph 10, claims 1-3 and 13 are rejected under 35 U.S.C. § 102 as being anticipated by Buell. It is stated that Buell teaches a stabilized platform comprising a payload platform for supporting a swiveling gun station, with a stabilizing system connecting the payload to the base including at least two motors 367, 377 for rotating the platform. Buell does not disclose a stabilized gun station, only an arrangement for correcting the output of a low cost gyroscope located at the gun station. There is also no support in Buell for the motors 367 and 377 being for rotating a platform. Referring to Figure 7 and column 9, lines 23 to 45, the motors 367 and 377 are components of an analog computing system for calculating pitch

and roll corrections, AP and AR. The motors 367 and 377 each have a sole function of driving a tachometer generator and two potentiometers.

In the Action, it is stated that Buell has a second sensor package including at least one level sensor is fixed to the payload platform 200, 201. There is no support in Buell for the suggestion that the second sensor package is fixed to a stabilized (payload) platform. The second sensor package, comprising an accelerometer triad 200 and a gyroscope 201, is only referred to as being located at the swiveling gun station. Furthermore, Buell does not disclose continuous stabilization based on the outputs of one sensor package, with periodic correction based on the outputs of a second sensor package.

In Buell (as in Walrath) calculation of pitch and roll errors is conducted on a continuous basis. However, Buell's level sensor package could not be polled continuously as taught by Buell if it were placed upon the stabilized platform as in the invention. Instant accelerations would create apparent sensor error to be corrected and cause the stabilized platform to be moved off level in response to short term acceleration error. In Buell, to avoid such error, the level sensor is placed "at" the platform, rather than on or fixed to it.

An alternative view of the relevance of Buell is also possible. Referring to column 2, line 65 to column 3, line 60 a stabilized platform 12 is mounted on a vehicle and stabilized by a gimbal arrangement with drive motors 24 and 26. The platform 12 is horizontally stabilized by means of vertical reference signals obtained from a level detector device 18. It is stated that "it is important for the antenna platform to be stabilized in a horizontal position with extreme

accuracy". As can be seen in Figure 1 the level detector 18 for continuously stabilizing platform 12 is mounted on the platform 12. The platform 12 is stabilized about two horizontal axes solely on the basis of the output of the level sensor 18. A reference table 14 is supported on a two-axis gimbal off stabilized platform 12. A gyroscope 40 provides position data for stabilizing the platform 14 on its two-axis gimbal, being one vertical and one horizontal axis.

However, in contrast to the present invention, the control of the stabilizing motors 24 and 26 for the stabilized platform 12 is not affected by any outputs of the gyroscope 40, and operation of the stabilizing motors 28 and 38 of reference table 14 is not influenced by the outputs of the level sensor 18.

Buell states in the ABSTRACT "The system includes further circuitry which is responsive to the output differential of the accelerometers to correct the error in the reading of the low cost gyroscope at the second location." Therefore Buell's system requires a Heading Reference Unit, Fig 2 # 50, and a Doppler Radar unit, Fig 2 # 48, neither of which are required in the present invention.

§103 - Hollandsworth in view of Walrath

In paragraph 14 of the Action, Claims 1-3, 6, 10-11 and 14-16 are rejected under 35 U.S.C. § 103(a) as being unpatentable over Hollandsworth '695 in view of Walrath '087. In paragraph 15, Claims 4-5 are rejected over the same references. Hollandsworth is cited as teaching stabilizing a platform. Stabilization is based on a gyro position measurement of movement of a base. Hollandsworth does not provide a second sensor package mounted on the

stabilized camera/payload platform or a controller periodically correcting for first sensor package anomalies based on information provided by the second sensor package.

Walrath teaches providing more than one sensor package on a vehicle, one package being more accurate and expensive than the other package. The less expensive package is periodically corrected based on the output of the more expensive package.

It would not have been obvious to modify Hollandsworth to include a second sensor package mounted on the camera/payload platform in view of Walrath. Walrath teaches mounting both sensor packages, although distant from one another, on the same framework which is of known flexural rigidity. Accordingly the outputs of the sensor packages are directly comparable. Accordingly Walrath would teach providing a second, more expensive and accurate, sensor package on the base platform on Hollandsworth and making direct comparisons between the outputs of the first and second sensor packages. It would not have been obvious to a person skilled in the art reading Walrath that they should provide a second sensor package on the stabilized camera/payload platform for correcting anomalies in a first sensor package provided on the base.

Walrath teaches accuracy by slaving the inexpensive sensor package to the expensive sensor package. In addition, to achieve accuracy, Walrath teaches constantly integrating vehicle flexure, which involves vehicle flexure algorithms, as well as system integration to the INS to correct for drift and other errors associated with the outputs of the low-cost attitude reference sensor to assure pointing accuracy.

By contrast, the present invention slaves the high cost rate sensors in sensor package A to the low cost level sensors in sensor package B.

The present invention has the salient feature that it can be transferred from one vehicle or airframe to another with no performance degradation, with no need to recalibrate any of the system's sensors and without any need to re-assess the new vehicle's frame flexure. The present invention eliminates the need for Walrath's teaching of "Continuously calculating said flexing location attitude as a function of a master input formed by the sum of said inertial navigations system output and said flexure angle computed in step (a) ..."

Walrath's described invention could not easily, (if at all,) be moved to a second vehicle, or more prohibitively, a different type or model vehicle because vehicle or airframe flexure would be different, and these algorithms are an integral part of Walrath.

Walrath in claim 10 states "sampling of both outputs at intervals between about .25 and .75 seconds."

In the present invention sensor package B is polled intermittently to correct long term anomalies of sensor package A. The polling relationship between sensor package A and B is preferably long term, generally greater than 2 seconds, to maximize sensor package B's relationship to the horizon and decrease sensitivity to accelerations which adversely effect the level sensor's output.

Walrath states that the INS costs upwards of $300,000 and weighs about 50 pounds. The present invention enables use of sensors weighing less than 2 pounds (and even less than a pound) and costing a fraction of the INS.

Walrath's features include a second sensor package, but Walrath relies on a microprocessor to periodically estimate steady state vehicle flexure between the two sensor packages. This vehicle flexure must not only be calculated for each type of vehicle as each vehicle will flex differently, but any unplanned flex between the two sensor packages, such as frame damage, mechanical inconsistencies such as drive train slippage, or otherwise, will render the calculations inaccurate. In the preferred embodiment, the present invention, unplanned flex is irrelevant, so there is no need or suggestion to incorporate any teachings of Walrath into Hollandsworth.

In paragraph 16, Claims 4-5 and 12 are rejected under U.S.C. § 103(a) as being unpatentable over the above references, combined with Algrain '938.

Algrain teaches in the abstract that the sensors may be located either on the base or the payload. In the present invention, sensor package A, high rate motion sensors, are placed upon the vehicle to determine actual vehicle motion which is then compensated for by drive motors 10 and 30 to maintain platform attitude as level, and motor 80 to maintain pointing or azimuth.

Sensor package B, e.g., a level sensor, cannot be placed on the vehicle as it would only indicate differences between itself and sensor package A, such as taught by Walrath and Buell. It would not be able to supply the required compensation for errors of motor or drive mechanism backlash, belt slippage, or inconsistencies, damage or failures to the vehicle frame, much less make corrections for those errors automatically and on the fly. The present invention's placement of the level sensor on the stabilized platform performs the above functions automatically and on the fly.

In contrast to Algrain's teachings, in the present invention sensor package A cannot be placed upon the payload platform because the sensitivity of sensor package A's rate sensors exceed the combined backlash and flexure between the drive motor position and the payload platform plate position. In such a closed loop system, the backlash is seen by sensor package A which then attempts to correct for backlash and which then causes a "hunting" vibration which can only be stopped by significantly detuning sensitivity or invoking complex payload platform algorithms. The present invention's positioning of sensor package B on the payload makes solving these problems unnecessary.

In the arrangement of one preferred embodiment of the present invention, sensor package B, used for providing periodic correction, is fixed to the stabilized camera/payload platform. Accordingly sensor package B may include sensors with relatively poor response but which provide absolute position sensing capability, which is a typical characteristic of level sensors. With the platform continuously stabilized using information from sensor package A, sensor package B is less influenced by rapid movements of the vehicle. Similarly sensor

package A may include relatively inexpensive motion sensing, as longer term drift is corrected for by using the absolute position information provided by sensor package B on the stabilized camera/payload platform.

New Claim 21 recites that the level sensing element of the second sensor group provides position information on the relative position of the payload platform while the first sensor package provides motion information of the base. This combination is believed patentably distinct for reasons similar to most of those set forth above with respect to Claim 35 and 36. More specifically, the second sensor group measures relative position of the stabilized platform, and so only monitors the stabilized platform, while the first sensor group monitors motion of the object/base (e.g., a boat or vehicle). By contrast, the cited references teach using two groups of sensors both monitoring motion of the object/base. They do not separately monitor the item being stabilized and the moving object, in conjunction with use of different information — position level and motion. Therefore, they cannot achieve the simple self-correction system of the invention.

New dependent Claim 37 emphasizes the use of a position sensor fixed on the payload platform. The fixing of the sensor on the payload platform is nonobvious for the reasons set forth above with respect to Claim 35.

New Claims 22-27 and 39-41 depend on Claim 21 or 37 and therefore are believed patentable. In addition, Claim 22 emphasizes the independence of the information provided by the first sensor group from the stabilized platform and thus from the information provided by

the second sensor group. This is not shown in the references.

Claim 23 expressly recites level sensors for measuring the position of the stabilized platform, and this is not shown in the references.

Claims 24 and 27 (and 39 and 41) emphasize that information is used from the second sensors at a different rate, i.e., less frequently, than the information from the first sensors. This is not shown in the references.

Claims 12 and 25 (and 40) emphasize that the stabilization in response to the first set of sensors causes drift and the second set of sensors are used to correct the drift. This is not shown in the references.

Claim 26 emphasizes that the first and second sensor groups provide a different type of information (position versus rate), which is not shown in the references i.e., particularly not in combination with the other aspects of the invention as recited in Claims 21 plus 37.

New Claims 28-33 and 42-45 are similar to Claims 22-27 and 39-41 and are believed patentable for substantially the same reasons.

Claim 34 is believed patentably distinct from the art of record, as it incorporates aspects combined from some of the dependent claims discussed above.

Having responded to each of the Examiner's concerns, Applicant asserts that the application is now in condition for allowance and solicits such action. If a telephone interview will advance the allowance of the application, enabling an Examiner's amendment or other meaningful discussion of the case, Applicant requests the Examiner contact Applicant's representative at the number listed below.

It is not believed that any additional fees are due; however, in the event any additional fees are due, the Examiner is authorized to charge Applicant's attorney's deposit account no. 03-2030.

Respectfully submitted,

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APPENDIX SHOWING CHANGES

2. The stabilized platform of Claim [1] 37, wherein the control system compensates for errors in the first sensor package using information obtained from the second sensor package.

3. The stabilized platform of Claim [1] 37, wherein the second sensor package includes two level sensors for sensing a position of the payload platform in two perpendicular directions.

4. The stabilized platform of Claim [1] 37, wherein the first sensor package is fixed with respect to the base.

5. The stabilized platform of Claim [1] 21, wherein the [first] second sensor package is mounted on the payload platform.

6. The stabilized platform of Claim [1] 37, further comprising a camera mounted on a payload platform.

7. The stabilized platform of Claim [1] 37, further comprising at least one of a chair and a table mounted on the payload platform.

10. The stabilized platform of Claim [1] 37, wherein the means for moving the payload platform [is rotated by] comprises three motors for rotating the payload platform about three perpendicular axes of rotation.

11. The stabilized platform of Claim 10, wherein the first sensor package includes sensors for determining rate of rotation about three perpendicular axes.

12. The stabilized platform of Claim [1] <u>37</u>, wherein the control system allows a user to set an initial payload platform position and provides self correction of the platform to the initial position.

13. The stabilized platform of Claim [1] <u>37</u>, wherein a universal camera mount is mounted on the payload platform and a camera is mounted on the camera mount, the camera mount allowing hands on control of the camera by [the] <u>a camera</u> operator and stabilization of the camera with the stabilized platform.

14. A method of stabilizing and self correcting a camera platform comprising:

positioning a stabilized camera platform on a moving [vehicle] <u>object</u>;

stabilizing the <u>payload</u> platform in at least two dimensions based on information collected by a first sensor package sensing motion of the moving [vehicle] <u>object independent of motion of the payload platform</u>; [and]

<u>sensing by a second sensor package a position of the payload platform relative to a predetermined position</u>; <u>and</u>

self correcting [a] the position of the <u>payload</u> platform <u>to the predetermined position</u> based on information collected by a second sensor package [mounted on the platform for sensing a position of the platform].

15. The method of Claim [14] <u>38</u>, wherein the information collected by the second sensor package is collected by a plurality of level sensors.

16. The method of Claim [14] <u>38</u>, wherein the stabilized platform is self corrected in two dimensions.

17. The method of Claim [14] 38 further comprising controlling a camera mounted on the platform by hands on operator control.

ABSTRACT OF THE DISCLOSURE

A stabilized platform is stabilized to compensate for motion caused by waves, currents, wind, and other motion during land, air, and sea operations of a camera. Although the stabilized platform is primarily described as useful for supporting a camera, the platform may be used to support other articles or persons. The stabilized platform includes a stabilizing system connecting a payload platform to a base. The stabilizing system including at least two motors for rotating the payload platform with respect to the base about two perpendicular axes of rotation providing the payload platform with stabilization in two dimensions. A control system stabilizes the platform based on information provided by a first sensor package [or other location] located on the base for sensing motion of the vehicle and a second sensor package on the platform. The use of the second sensor package allows the stabilized platform to be self correcting. A camera when mounted on the payload platform may be manually or remotely controlled.

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